but shows that there can be no middle ground between the common estimate of the plant and that which a logical interpretion of all the facts now disclosed forces upon us.

Each successive season a fresh series of analyses and practical tests were made and put upon record, beginning with that stage of the development of the plant, when the percentage of cane sugar had previously been supposed to have reached its maximum, and extending them through the after period of juice-ripening, brought on by the timely separation of the immature grain, up to the time of frost. It was found that the saccharine strength of the juice, under the new conditions, constantly increased in a fixed ratio, and that the life of the plant was prolonged from a month to two months beyond the natural period.

(To be continued.)

THE ASTRONOMICAL EXHIBITS AT THE WORLD'S FAIR.

THE Astronomical Exhibits at the World's Fair at Chicago represent fairly well the present state of the science of astronomy. But they are scattered about in the various buildings so as to make it difficult even to find them all, to say nothing of systematic study and comparison of them one with another. In a general way, the most important astronomical displays are to be found among the educational exhibits, which are located in the west and south galleries of the Manufactures and Liberal Arts Building. In the exhibit of Harvard University, in the south gallery, is a splendid collection of astronomical photographs made by the Harvard College Observatory. Especially interesting are several photographs of stellar spectra and of nebulæ and clusters. One photograph of a portion of the moon's disk represents an enlargement of over one thousand diameters. Nowhere else can be found a better illustration of the great usefulness of photography in astronomy. The collections of Draper and Langley are to be found in the exhibits of the University of the City of New York and of the Western University of Pennsylvania. The four-inch almacantar, which is the first one constructed and used by Dr. Chandler, is in the exhibit of De Pauw University. The exhibit of Johns Hopkins University contains a fine collection of diffraction gratings and photographs of spectra by Professor Rowland. In the German Educational Exhibit, in the west gallery, are specimens of the famous Jena optical glass, the original spectroscope of Kirchhoff, and some fine mathematical models by Brill. Here is also shown the magnetic apparatus of Gauss and Weber. Near by, in the English Exhibit, is the display of the Royal Astronomical Society, containing a large number of astronomical photographs by Roberts, Gill and Abney, and still others from the Royal Observatory at Greenwich. Boeddicker's drawings of the Milky-way and Dr. Common's five-foot glass speculum are in the English exhibit. The latter is unsilvered and has evidently been placed with greater care to secure safety than visibility. In the Swiss Exhibit, in the main aisle of the Manufactures Building, is a display of instruments by La Société Genevoise.

The exhibits of the American makers of astronomical instruments are in the north gallery of the Manufactures Building, just over the main aisle. Warner and Swasey show a fine twelve-inch equatorial telescope, with smaller instruments, and also the mounting of the great forty-inch Yerkes telescope, which is set up at the north end of the main aisle. The appearance of the great telescope gives an impression of symmetry and strength. The lens for it is being made by Alvan Clark & Sons, of Cambridgeport, Mass. They report satisfactory progress, but say that it will not be finished for a year or more. The Clarks, by the way, make no exhibit at Chicago. J. A. Brashear, of Allegheny, Pa., exhibits the stellar spectroscope for the Yerkes telescope. He also shows an eighteen-inch and a fifteen-inch objective, gratings, specula, etc. G. N. Saegmuller, of Washington, exhibits a variety of instruments of precision, among which are a nine-inch equatorial telescope and a four-inch steel meridian circle. The exhibit of the Gundlach Optical Company also deserves mention. The American instrument-makers, as a whole, make a most creditable showing. The displays of the foreign instrument-makers are, many of them, located in the Electricity Building. Schott und Genossen, of Jena, show a large number of specimens of optical glass, and among them are two twenty-three-inch discs of the celebrated Jena glass. Merz, of Munich, shows two equatorial telescopes and several telescopic objectives, the largest of which is ten inches in diameter. The Repsolds, of Hamburg, seem not to be represented—a fact much to be regretted.

Dr. Gill's interesting stellar photographs are in the Cape Colony Exhibit in the Agricultural Building, and the Lick Observatory display is in the educational department of the California State Building, and is strangely enough mixed up with the kindergarten exhibit there.

The U. S. Naval Observatory Exhibit is a small observatory located northeast of the Government Plaza, and is in charge of Lieut. A. G. Winterhalter, U. S. N. There are a small equatorial telescope, photoheliograph and many smaller instruments. The Weather Bureau Exhibit, a short distance to the west, is well worth a visit. The exhibit of Coast Survey apparatus, in the U. S. Government Building, is full of interest, from the geodetic standpoint.

SCIENCE TEACHING IN SECONDARY AND PRIMARY SCHOOLS.

DR. GEO. G. GROFF, LEWISBURG, PA.

IT has long been a dream of scientists that the time would come when the elements of natural history and of the physical sciences would be taught in secondary and primary schools. To thinking people it does not seem necessary to argue that every boy should be instructed in the elements of chemistry, natural philosophy, botany, geology, zoölogy and physiology. To persons not teachers, it would seem no difficult matter to find a place in the school curriculum for the elements of the above sciences. But it remains true that they are not taught, or taught to such an extent, and in such a manner, as to produce results entirely worthless.

Why is this condition of things prevalent? Why, after all that has been said and written, is there is no change for the better? The answer seems to be this: The elements of the sciences are not taught in elementary and primary schools for the reason that the teachers themselves have never been taught, and without instruction they feel that to attempt to teach these branches they would be blind leaders of the blind. More than this, the schools whose special duty it is to train teachers for primary and secondary schools, have not begun to do any real work in the line of science instruction. The sciences in these schools are so placed in the background that practically no training at all is given in them. It is then no wonder that the graduate of such a school does not feel capable of giving any instruction in even the elements of the sciences. To demonstrate the above statements the catalogues of the Pennsylvania State normal schools will be examined, and certain results tabulated. It will be seen that the teachers of *arithmetic* and *grammar* far

outnumber those of science. But let the official announcements of the schools speak for themselves.

	No. Students.	Teachers Grammar.	Teachers Mathematics.	Teachers Science.	Remarks.
1st District, - -	800	6	9	1	
2nd " - -	979	2	5	2	Physiology taught by a physician.
3rd " - -	662	2	5	2	
4th " - -		1	1	1	Not yet opened.
5th " - -	360	1	2	1	
7th " - -	360		1	2	The science teachers devote but part of their time to their own dept.
8th " - -	579	2	2	1	Science teacher is also instructor in gymnasium.
9th " - -	666	2	2	1	
10th " - -	711	1	1	2	Assistant teaches history and zoology.
11th " - -	500	1	1	1	The science teacher is also teacher of ancient languages.
12th " - -	530	1	1	1	
13th " - -	526	1	1	1	Science teacher teaches grammar also.
12 schools,	6,673	20	31	16	

By above table it will be seen that for 6,673 students some sixteen science teachers are provided, but in six instances these teachers give instruction in other branches, leaving but ten teachers devoting all their time to scientific instruction. The extreme illustration is seen in the first district, where fifteen teachers instruct in mathematics and grammar to one solitary teacher in science.

If, however, we further examine the catalogues, we find that in the elementary course (which is the only course the great bulk of the students take) the sciences required are physiology and hygiene, elementary natural philosophy and botany. To teach physiology and hygiene to teachers, it might readily be supposed that a person trained in medicine would be demanded, but only *one* such trained teacher is found in the twelve schools. A fair knowledge of elementary natural philosophy is imparted, but the work in botany is abridged to so short a time that it is questionable whether the graduates are able to do much with it when they become teachers themselves.

In the scientific course, which extends over two years, chemistry, zoology and geology are taught for one term each, natural philosophy for two terms. The same criticism is applicable to the scientific work in this course as is made above for the work in botany.

If, from the strictly professional schools we now turn to the academies and colleges, which prepare a large proportion of the teachers of the state, we will find much the same condition of affairs. As a rule, the academies and seminaries can afford but a single science teacher. With the colleges it is but little better, except that largely these institutions have been able to secure two professors for the scientific branches, chemistry and physics being assigned to one, while geology and the organic sciences are given to the other. Pennsylvania has twenty-six colleges for men (part of these co-educational) and eleven for women (Last report of U. S. Commissioner of Education). Of these thirty-seven institutions, the University of Pennsylvania, Lehigh University, the University of Western Pennsylvania, Lafayette College and Bryn Mawr College are the only ones in any wise fully equipped for scientific work. In some cases there are more than two science professors in one institution, but in other cases there is but a single instructor. The writer has not, in his possession, catalogues of all the colleges, and hence cannot make a tabulated statement, as has been done for the professional schools.

The answer then is reached. Scientific instruction in the public schools is a failure because teachers are not trained to impart it. At present, mathematics and grammar are considered of far more importance than science in the training of teachers. How long this state is to continue no one can affirm. The only solution of the problem is better all-round preparation for teachers.

ELECTRICAL COOKING.

Some years ago (in December, 1890) the writer made some experiments with a view to determining the efficiency of electrical cooking, as the general opinion at that time was that any such employment of electricity would be too inefficient to be commercially practicable, and the writer had reason for believing otherwise. These experiments showed conclusively that the use of electricity for cooking was more economical and efficient than the use of coal in an ordinary cooking stove, but, as it was the intention of the writer to take out patents on several points, these results were not published at the time.

Since 1890, the fact of the efficiency and low cost of electrical cooking has been generally recognized, not only theoretically, but also in practice. But although there are now at least a dozen companies engaged in producing electrical cooking apparatus, and their productions are finding their way into hotels, dining cars, steamers, and private houses, so far as the writer knows, there have not as yet been published any tests of the relative efficiency of the new apparatus and the ordinary cooking stove. For this reason the following results may be of interest, the more especially as the results show the truly awful waste of fuel at present taking place, and the direction in which improvement both in heating and cooking must be looked for.

Details of apparatus used in making test. The cooking stove was of the ordinary type, the enclosed grate which holds the fuel being twelve inches long by six inches wide by six inches deep. Area of top of stove, seven square feet. Size of oven, 2x1.6x1.6 feet. Number of orifices on top of stove, six. Orifices eight inches in diameter. A damper is so arranged that the heat passes directly up the chimney, after passing the six orifices for culinary utensils, or may be directed around the oven, after passing two orifices only. The total radiating surface is 37,200 square centimetres, approximately, and the average all day temperature, so near as could be ascertained, nearly 100 degrees C.

The box for electrical heating was a cube whose sides were one foot in length. It was of polished tin, but no attempt was made to render it more bright than it was when bought. The box was heated inside by passing a current of electricity through a coil of iron wire wound inside the box. The watts used in heating could be found by multiplying the current passing through the coil by the difference of potential between its ends, a thermometer inserted in the box giving the corresponding temperature.

The total quantity of coal used in the stove, obtained by taking the average of several weeks, was thirty pounds per day. Taking the average value for the thermal equivalent of good coal, this would represent the production of 100,000,000 calories, and therefore the efficiency will be given by dividing the total number of calories of useful work obtained from the stove by 100,000,000.